REACTION INSTRUMENTS

INSTRUCTION MANUAL

MODEL 410

HF MULTICOUPLER

SERIES

August, 1982
Rev. 2

REACTION INSTRUMENTS, INC.
1916 ISAAC NEWTON SQUARE WEST · RESTON, VIRGINIA 22090
(703) 471-6060

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TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

1.1 Description

1.2 The Reaction Instruments Model 410 HF Multicoupler is a compact unit which allows coupling of up to sixteen HF Receivers to a single antenna. A low noise input amplifier provides a nominal gain of 4 dB and achieves a wide dynamic range over the entire HF band.

1.3 The Model 410 HF Multicoupler is also available with a choice of the number of outputs and as a single or dual channel unit. The standard unit operates from either 115 or 230 Vac and is housed in a standard EIA 1¾" high rack mount chassis. A Tempest Option is available.

1.4 Options Available

1.5 Choice of number of outputs up to a maximum of sixteen.

1.6 Tempest.

1.7 24 Vdc operating voltage.

1.8 Dual input - switch selectable.

1.9 Lightning protection.

1.10 Electrical Specifications

Number of outputs	16 maximum
Impedance	50 ohms
Input return loss	>18 dB
Output return loss	>20 dB
1 dB band limits	100 kHz to 32 MHz
Nominal gain	4 dB
Gain ripple	$\pm\frac{1}{2}$ dB
Two-tone intermodulation products*	>50 dB down
Isolation - output to output	>40 dB
Isolation - reverse	>50 dB

1 dB gain compression (ref. to output)	>16 dBm
Noise figure	6 dB max. (30 MHz)

*Test tones (referred to output) 0.5 Vrms at 16 and 18 MHz - 3rd order.

1.11 General Specifications

Style	EIA standard chassis, 1¾ inches high, 15 inches deep, suitable for 19 inch rack mounting
Connectors	BNC - rear panel mounted
Power	115/230Vac ±10%, 48 to 62 Hz, 35 watts, 24 Vdc - optional
EMI	Tempest option available
Temperature - operating	0° to 50° C
Weight	12 lbs.

SECTION II

INSTALLATION

2.1 Introduction

2.2 This section contains information and instructions for the installation of the model 410 HF Multicoupler.

2.3 Initial Inspection

2.4 This equipment was carefully tested and inspected before shipment. It should be in perfect electrical and mechanical condition upon receipt. Please test and inspect the equipment immediately upon receipt for physical damage in transit.

2.5 Power Requirements

2.6 The Model 410 can be operated from 115 and 230 Vac. (24 Vdc optional.)

2.7 The selection of line voltage is made by means of a switch on the dc power supply. Access to the switch is gained by removing the top cover of the multicoupler.

2.8 Caution: The equipment leaves the factory set for 115 Vac operation. The ac selection
switch must be changed prior to operation at 230 Vac.

2.9 Rack Mounting

2.10 The Model 410 is a rack mounted instrument designed for use in a standard EIA 19" rack. Other configurations can be supplied, if desired.

2.11 The unit may be closely stacked with other equipment without special attention to cooling.

SECTION III

OPERATING INSTRUCTIONS

3.1 Introduction

3.2 This section explains the controls and operation of the Model 410 HF Multicoupler.

3.3 Location of Controls and Connectors

3.4 The front panel contains the master power switch and an input selector switch (when ordered). The rear panel contains all input/output connectors. These include input and output BNC connectors in addition to the ac power receptacle.

3.5 Turn-On Procedure

3.6 Before plugging the unit in, be sure that it is set for the proper line voltage.

3.7 Turn on the unit by pushing the power switch which should light in the ON position.

3.8 Input/Output

3.9 Simply apply the input signal to its connector and obtain multiple output signals at the output connectors. Operation with unterminated outputs will not harm the unit. For the dual input option, the front panel switch selects one of the two inputs.

3.10 Unauthorized Field Adjustments

3.11 In order to achieve the stringent performance requirements, each element of this unit has been carefully aligned and sealed at the factory. Unauthorized field adjustments will be considered cause for cancellation of the warranty.

SECTION IV

PRINCIPLES OF OPERATION

4.1 **Amplifier** (Refer to Drawing 40802)

4.2 Connector J1 accepts input signals in the band 0.1 to 32 MHz. A constant-resistance high-pass filter including inductors L1, L2, and L3 causes applied signals at frequencies below about 80 kHz to be dissipated in dummy load R1. Signals in the HF band are coupled via a matching network and low-pass filter (C5, L4, and C6) to the gate of transistor Q1, a high-level VMOS field-effect transistor operating in a common-source, class A mode. The forward gate bias for the device, controlled by potentiometer R2, is adjusted to produce a quiescent drain current of 0.5 ampere.

4.3 Current transformer T1 samples the RF channel current in Q1 and applies a suitable fraction of this current to the gate input circuit so as to produce a nominal 50 ohm input impedance for the stage.

4.4 The dc component of the Q1 drain voltage is fixed at +15V by regulator U1, whose output is coupled to the drain by RF choke L5.

4.5 The ac signal component of the drain current in Q1 is coupled by blocking capacitor C10 to a 30 ohm transmission line terminated at the far end by the parallel connection of resistors R71, R72, and R77. These resistors also function to hold the dc voltage on the transmission line at -8 volts.

4.6 The transmission appears as a flat resistive load to the Q1 stage. The net voltage gain for inband signals between the input at J1 and any point along the transmission line is nominally X4.

4.7 The sixteen isolated inputs of the multicoupler are produced by identical emitter-follower stages Q2 through Q17, which are uniformly spaced along the transmission line. Each emitter-follower has, in the frequency band of interest, a flat frequency response and a high input impedance, so that loading of the transmission line by the emitter-follower is negligible.

4.8 In a typical emitter-follower stage, Q2 for example, the low output impedance of the stage is brought up to 50 ohms by series resistor R8. Blocking capacitor C11 prevents emitter-follower supply voltage, applied via L6 and R6, from reaching the RF output connector at J3. When the RF output at J3 is match-terminated, the additional drop in signal voltage across R8, nearly 2:1, brings the overall voltage gain of the multicoupler to approximately 6 dB.

4.9 Voltage regulator U2 provides -12V to all of the emitter-follower stages. Filtered but unregulated B+ and B- for both regulators is produced by a capacitor - input full wave center-tapped bridge rectifier drive by a pair of parallel connected power transformers. Shunt capacitors on the ac side of the rectifier bridge help to reduce conducted interference on the power line. Switchable primary windings allow operation on either 115 or 230 Vac.

4.10 **Lightning Protection** (Refer to Drawing 31802)

4.11 Optional protection against damage due to lightning-induced input surges or high-level RF inputs is provided by a lightning protection module which can be installed within the Model 410 chassis in series with the RF input to the amplifier.

4.12 The module uses a gas-type surge voltage protector shunting the RF input. This is followed by a multi-section low pass filter and by reverse-biased diodes CR1 and CR2 which act as high speed diode clamps.

4.13 The low-pass filter, which includes inductors L1 through L5, has a flat passband extending to beyond 32 MHz, and functions primarily as a kind of impedance inverter separating the gas-type surge protector from the clamping diodes.

4.14 A large amplitude incident voltage surge will initially propagate down the low-pass filter and become instantaneously clamped at +5V or -5V, depending on the polarity of the surge, by diode CR1 or CR2. The initial diode current may be many tens of amperes.

4.15 With an ignition delay of less than a microsecond, the gas tube at the input will then begin to conduct, the major part of the surge energy being either absorbed by the gas tube or reflected back out the input terminal. Due to the impedance isolation provided by the series connection of inductors L1 through L5, almost all of the incident surge current following an initial ignition delay flows through the gas tube.

4.16 The surge protection circuit will withstand the repeated discharge into its input of a 1000pF capacitor charged to 10 kVdc.

SECTION V

SERVICING

5.1 Multicoupler Module

5.2 Reaction Instruments does not recommend any type of periodic maintenance in normal use of this equipment. The following information is provided in the event of a random component failure in situations where the unit cannot be returned to the factory. Do not hesitate to call the factory (collect) if any problems are encountered.

5.3 Section IV, "Principles of Operation", discusses the basic theory of the multicoupler. This section shoud be reviewed before attempting any troubleshooting procedure.

5.4 In the event of an apparent malfunction of the multicoupler, an important first step is to verify that the multicoupler itself is indeed at fault. For this purpose, the coaxial cable leading to the multicoupler input jack should be disconnected and reconnected directly to one of the receivers normally connected to the multicoupler. Only if this results in normal operation for the receiver in question should a malfunction in the multicoupler be assumed.

5.5 The next step in the troubleshooting is to verify that the regulated and unregulated supply voltages are within normal limits. For this purpose, it is necessary to remove the top cover plate of the amplifier module to gain access to the voltage regulators, U1 and U2 in drawing 40802. With a 115 Vac line input, the unregulated B+ at terminal E18 should be 20 +/-1 Vdc, and the B-, at terminal E19, should be 19 +/-1 Vdc. In the event of loss of load, due perhaps to an open circuit failure of one of the regulators, these voltages will increase to about 25 Vdc. The normal regulator output voltages are 14.5 +/-0.5 Vdc for the positive regulator (U1), and -12 +/-0.5 Vdc for the negative regulator.

5.6 Additional simple dc checks will further localize circuit malfunctions in the multicoupler. The dc current drawn by Q1, measured by placing a dc ammeter in series with the unregulated B+ line, should be approximately 500 mA. Gate bias potentiometer R2 is used to adjust the operating current in Q1. The normal gate bias is in the range of 4 to 6 Vdc.

5.7 If R2 cannot be adjusted to produce the specified drain current, the probable cause is an open circuit failure in Q1. If the measured gate voltage is near zero at all settings of R2, the probable cause is a gate-source short circuit in Q1. In either case, Q1 should be replaced.

5.8 Similar dc checks can be used to troubleshoot the emitter-follower output stages. The normal operating current of each emitter-follower is 40mA, resulting in a 2.8 Vdc drop across each of the 68 ohm emitter pull-down resistors. Direct comparison of base and emitter voltages on the emitter-followers will quickly localize a failed component.

5.9 Caution: The NPN transistors used have very high gain-bandwidth products, and even a short length of wire making a direct connection to the base or emitter of one of these stages may induce a parasitic UHF oscillation. To avoid this possibility, add a several thousand ohm resistor in series with the end of the volt meter test lead, and make the connection to the transistor terminal via the resistor.

5.10 Power Supply

5.11 The power supply is a full-wave center tapped unregulated supply rated at a nominal 650 mA. Additional filtering is provided in order to limit conducted EMI resulting from switching transients in the rectifiers.

5.12 If fuses continue to blow, this would indicate either shorted rectifier diodes or shorted capacitors C1, C2, C3, C4 which can be checked with an ohmmeter.

5.13 With the power supply operating under load (i.e. - multicoupler module connected), the B+ and B- ripple should be less than 0.6 Vp-p at twice the line frequency. If ripple is seen at the line frequency, check the rectifier diodes. If excessive ripple is seen at twice the line frequency, check the filter capacitors.

SECTION VI

PARTS LIST

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

PARTS LIST

PL 40801-16 | REV A | DATE 3-81

MODEL NO. 410B

JOB 4486

DATE

TITLE: P.C. ASSY, HF MULTICOUPLER

SHEET 1 OF 4

PE [illegible] 2-26-81

BY E.A.T.

CHK J.P.B. 2/20/81

CONTRACT NO.

LIST NO.	QTY -16			DESCRIPTION	PART NO./SPEC NO.	MANUFACTURER/ FSCM	DWG ITEM	CIRCUIT SYMBOL
1	1			P.C. Board, Model 410B-16	40800	R.I.I.	1	
2								
3	20			Terminal, P.C.B.	160-3653-02-1	Cambion		E1-E20
4	1			Choke, 220μh	MS75085-11 or 1025-76	Delevan		L1
5	1			Choke, 68μh	MS75085-05 1025-64	Delevan		L2
6	1			Choke, 100μh	MS75085-07 1025-68	Delevan		L3
7	1			Choke, .22μh	MS75083-05			L4
8	1			Choke, Fixed	120T#26 CF111-Q2 Torroid	R.I.I. (I.G.)		L5
9	16			Choke, 470uh	3500-24	Delevan		L6-L21
10	16			Transistor, RF	MRF-517	Motorola		Q2-Q17
11	3			Capacitor, .033μf	C280CF/A33K	Amperex		C1, C2, C3

NOTE: Rev. A - See ECR 264

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

PARTS LIST

PL 40801-16 REV A

DATE

MODEL NO. 410B

JOB 4486

DATE

TITLE: P.C. ASSY, HF MULTICOUPLER

SHEET 2 OF 4

PE

BY E.A.T.

CHK

CONTRACT NO.

LIST NO.	QTY -16			DESCRIPTION	PART NO./SPEC NO.	MANUFACTURER/ FSCM	DWG ITEM	CIRCUIT SYMBOL
12	17			Capacitor, .1μf, 50V	CK05BX104K			C4, C10-C26
13	1			Capacitor, 15-60PF		Erie		C5
14	1			Capacitor, .01μf, 100V	CK05BX103K			C7
15	1			Capacitor, 68PF, 500V	CM05FD680J			C6
16	2			Capacitor, 1μf, 50V	CS13BG105K			C8, C30
17	1			Capacitor, 4.7μf, 50V	CS13BG475K			C27
18	4			Capacitor, 22μf, 35V	CS13BF226K			C9, C28, C29, C31
19	2			Resistor, 39Ω ± 5% 1/4W	RCR07G390J			R70, R77
20	1			Potentiometer, 10KΩ	RJ26CW103			R2
21	17			Resistor, 1KΩ ± 5% 1/4W	RCR07G102J			R3, R9, R13, R17, R21, R25, R29, R33, R37, R41, R45, R49, R53, R57, R61, R65 R69

NOTE:

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

PARTS LIST

PL 40801-16 REV A

MODEL NO. 410B

JOB 4486

DATE

TITLE: P.C. ASSY, HF MULTICOUPLER

SHEET 3 OF 4

PE

BY E.A.T.

CHK

CONTRACT NO.

LIST NO.	QTY -16			DESCRIPTION	PART NO./SPEC NO.	MANUFACTURER/ FSCM	DWG ITEM	CIRCUIT SYMBOL
22	1			Resistor, 24Ω ± 5% 1/4W	RCR07G240J			R4
23	1			Resistor, 56Ω ± 5% 1/4W	RCR07G560J			R5
24	16			Resistor, 18Ω ± 5% 1/4W	RCR07G180J			R7, R11, R15, R19 R23, R27, R31, R35, R39, R43, R47, R51, R55, R59, R63, R67
25	17			Resistor, 47Ω ± 5% 1/4W	RCR07G470J			R1, R8, R12, R16 R20, R24, R28, R32, R36, R40, R44, R48, R52, R56, R60, R64, R68
26	16			Resistor, 68Ω ± 5% 1/2W	RCR20G680J			R6, R10, R14, R18, R22, R26, R30, R34, R38, R42, R46, R50, R54, R58, R62, R66
27	1			Terminal, Bifercated	1496A	USECO		E21
28	2			Resistor, 300Ω ± 5% 1/2W	RCR20G301J			R71, R72
29	1			Resistor, 337Ω ± 1% 1/4W	RN55D2370			R73

NOTE:

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

PARTS LIST

PL 40801-16 REV A

DATE

SHEET 4 OF 4

MODEL NO.	JOB 4486	TITLE: P.C. ASSY, HF MULTICOUPLER
	DATE	
410B	PE	BY E.A.T. / CHK / CONTRACT NO.

LIST NO.	QTY -16			DESCRIPTION	PART NO./SPEC NO.	MANUFACTURER/ FSCM	DWG ITEM	CIRCUIT SYMBOL
30								
31	1			Resistor, 2.55K $\pm$ 1% 1/4W	RN55D2551			R74
32	1			Transformer, Fixed	13T#26-PR1 1T#26-SEC	Permag Dixie		T1 (Note 1)
33	1			Transistor	VMP-4			Q1
34	1			Regulator	LM317T			U1
35	1			Regulator	LM320T			U2

NOTE: 1. T1 wound on BBR 7953-1 Torroid

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

PARTS LIST

PL 21670 | REV | DATE

MODEL NO. 410A, 410B

JOB 4486

DATE 6-1-81

TITLE: P.C. ASSEMBLY LIGHTNING ARRESTOR

SHEET 1 OF 2

PE | BY JOB | CHK | CONTRACT NO.

LIST NO.	QTY -1	QTY -2	QTY -3	DESCRIPTION	PART NO./SPEC NO.	MANUFACTURER/ FSCM	DWG ITEM	CIRCUIT SYMBOL
1	1			P.C. Board	21669	R.I.I.	1	
2	1			Spark Gap	B1C90/20	Siemens	2	
3	AR			Buss Wire	No. 22		3	
4	2			Resistor, 2K, 1/4W, 5%	RCR07G202J	A.B.		R1, R2
5	1			Resistor, 10K, 1/4W, 5%	RCR07G103J	A.B.		R3
6	1			Capacitor, 51pf	CM05FD510J	CDE		C8
7				Capacitor, .01μf	CM05BX103K			C10
8	1			Capacitor, 6.8pf	CSR13BF685K			C11
9	2			Diode,	Unitorde Only UES1001			CR1, CR2
10	1			Diode,	1N4740			CR3

NOTE:

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

PARTS LIST

PL 21670 | REV | DATE

MODEL NO. 410A 410B

JOB 4486

DATE 6-1-81

PE

TITLE: P.C. ASSEMBLY LIGHTNING ARRESTOR

SHEET 2 OF 2

BY JOB | CHK | CONTRACT NO.

LIST NO.	QTY -1	QTY -2	QTY -3	DESCRIPTION	PART NO./SPEC NO.	MANUFACTURER/ FSCM	DWG ITEM	CIRCUIT SYMBOL
11	1			Inductor 3½T Turn		Coilcraft		L1,
12	3			Inductor S+D 8½ Turn		Coilcraft		L2, L3, L4
13	1			Inductor 4½T		Coilcraft		L5
14	2			Capacitor, 200pf	CM05FD201J	CDE		C1, C2
15	4			Capacitor, 220pf	CM05FD221J	CDE		C3, C4, C5, C6
16	2			Capacitor, 1uf	CK06BX105K			C7, C9

NOTE:

PARTS LIST MODEL 414-12, 414A-12, 414A-8, 414-2-6, 410A, 410B

REACTION INSTRUMENTS
RESTON, VIRGINIA FSCM 31887

TITLE: P. C. ASSEMBLY
POWER SUPPLY
UHF MULTICOUPLER

PL 31537 | REV B | DATE 3-81

DATE 2-1-80 | JOB 4467 | BY C. Dean | CHK J.P.B. 3/5/80 | APP B.G. 3/10/80 | APP | CONTRACT NO. | SHEET 1 of 1

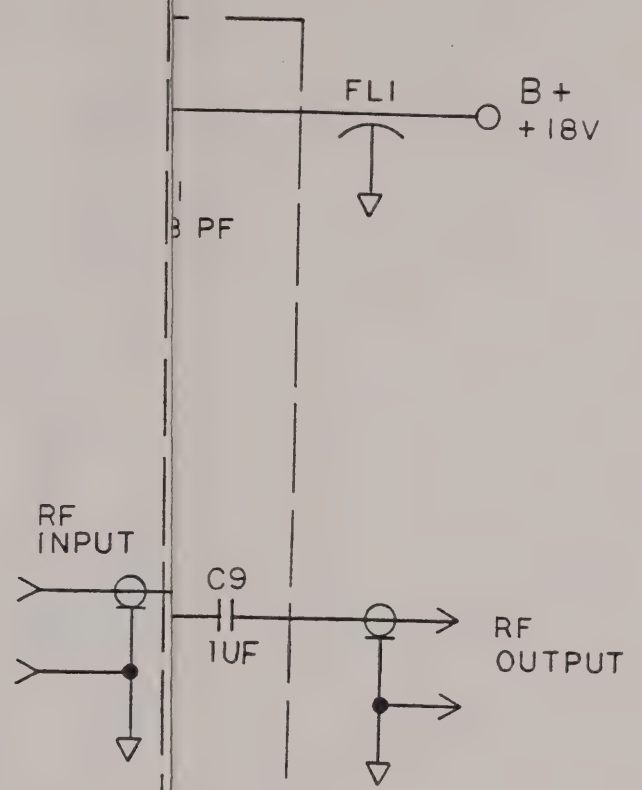
ITEM	QTY -1	QTY -2	QTY -3	DESCRIPTION	PART NO./ SPEC NO.	MANUFACTURER/ FSCM	CIRCUIT SYMBOL
1	1			PC Board	31536B	RII	
2	8			Standoff, Swage	9705B-B-0440-0	Amatom	
3	20			Terminal, Swage	160-3653-02-01	Cambion	E1 - 20
4	1			Switch DPDT	31775	R.I.I. (Stackpole)	S1
5	1			Fuse 1/2 A 250 V	313.500	Buss	F1
6	2			Fuse Clips	31269	Buss	
7	4			Capacitor, 100μF, 30 V	CL65BH101MPE		C1 - 4
8	5			Capacitor, 1000μF, 25 V	TVA 1211	Sprague	C5 - 9
9	4			Diode	1N4933		CR1 - 4
10	4			Diode	1N4001		CR5 - 8
11							

NOTE: Rev. A-See ECR183 Rev. B - See ECR 259

SECTION VII

DRAWINGS

REVISIONS		
DESCRIPTION	DATE	APPROVED
	7-2-82	



OB	REACTION INSTRUMENTS	RESTON, VA. FSCM 31887
/81	SCHEMATIC DIAGRAM LIGHTNING PROTECTION CIRCUIT	
SHEET	SCALE / SIZE / DWG NO.	REV

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	ECR 352	7-2-82	

P. C. ASSEMBLY 21670

R3
470

FL1

B+
+18V

C10
.01

CR3
1N4740

C11
6.8 PF

R1
2K

CR1
UES 1001

RF
INPUT

L1 L2 L3 L4

C7
1UF

L5

C9
1UF

RF
OUTPUT

C1
200
PF

C3
220
PF

C5
220
PF

SPARK
GAP

C2
200
PF

C4
220
PF

C6
220
PF

C8
51 PF

R2
2K

CR2
UES 1001

E1 E2

P.C. ASSY	21670
SCHEMATIC	(31802)
DRILL DWG	21669
ARTWORK	21668
410B	
410A	
MODEL NO.	NEXT ASSY

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOL: .XX: ± .01 .XXX: ± .005 ∠'s: ± 30'
± ± BEND 'R' MIN BEND RELIEF MIN

FINISH

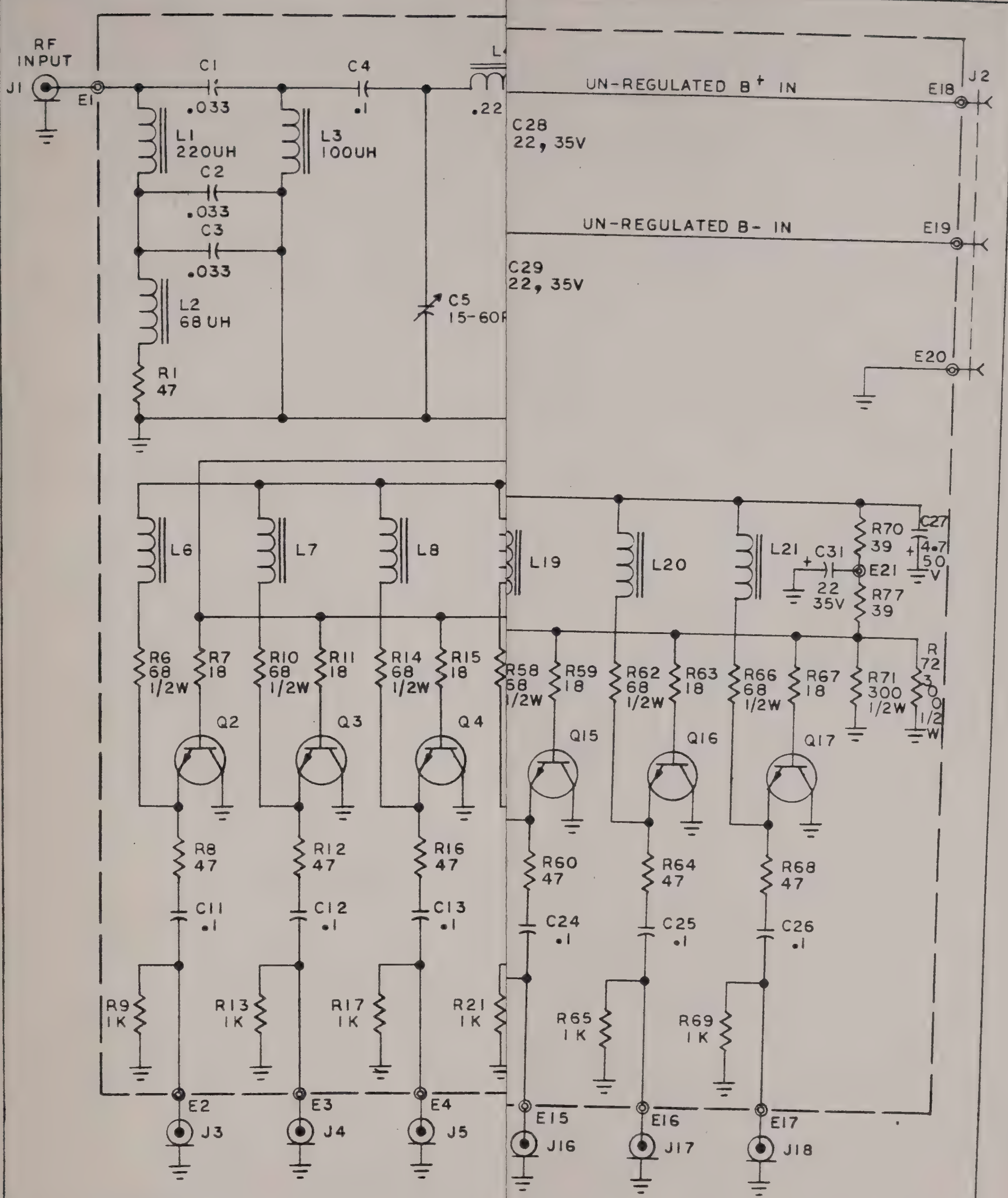
MATERIAL

MODEL NO.	410A, 410B
JOB NO.	4486
BY	J. OBRIEN
CHK	J.P.D. 6/8/81
P.E.	

REACTION INSTRUMENTS RESTON, VA. FSCM 31887

SCHEMATIC DIAGRAM LIGHTNING PROTECTION CIRCUIT

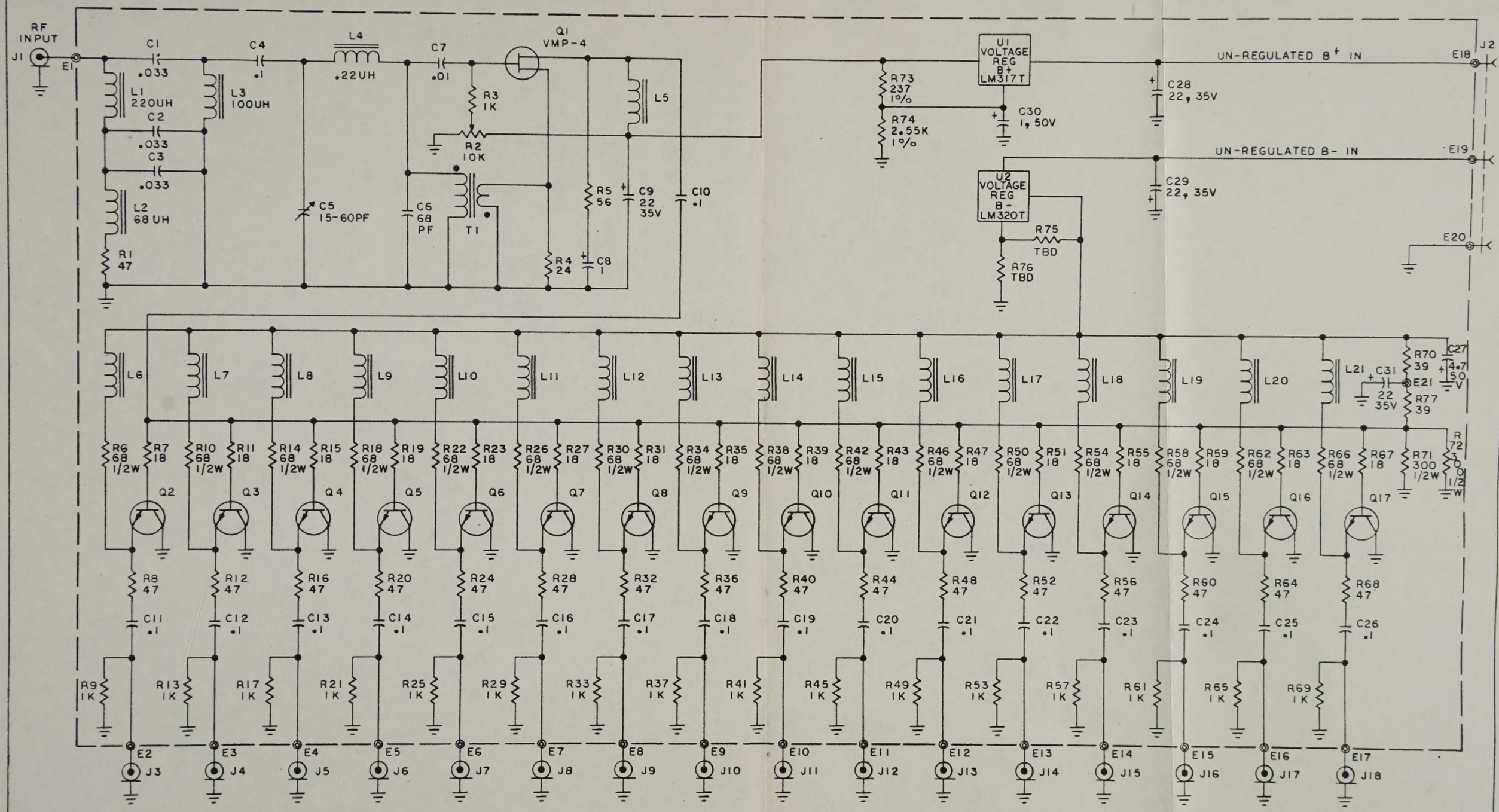
SHEET	SCALE	SIZE	DWG NO.	REV



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   - A. ALL RESISTORS ARE IN OHMS,
   - B. ALL CAPACITORS ARE IN MICRO
   - C. ALL TRANSISTORS ARE MRF517.
   - D. ALL INDUCTORS ARE 390UH.

410B	SCHEMATIC DIAGRAM HF MULTICOUPLER AMP ASSEMBLY
4486	
N. HEON	
JPB. 2/24/81	
[illegible] 2-26-81	
	D 40802



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   A. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W.
   B. ALL CAPACITORS ARE IN MICROFARADS.
   C. ALL TRANSISTORS ARE MRF517.
   D. ALL INDUCTORS ARE 390 UH.

40801		410B	SCHEMATIC DIAGRAM HF MULTICOUPLER AMP ASSEMBLY
(40802)		4486	
40800		N. HEON	
40799		2-13-85	
		2-26-85	
410B	40815		1 1 — D 40802